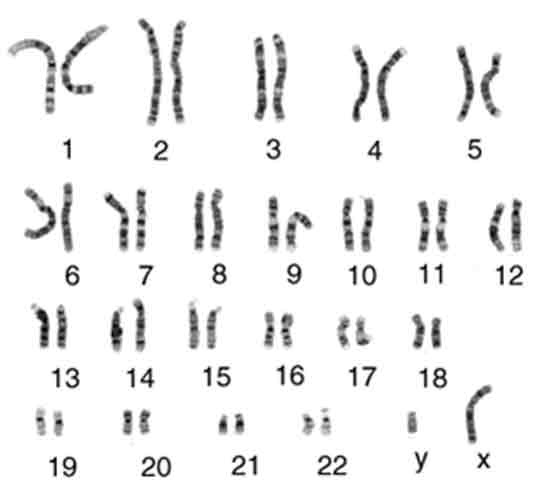
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**Unit 8 Notes, Part 2: Meiosis**

Ms. Ottolini, AP Biology

**New Vocabulary**

1) Mitosis is the process of creating new body cells (somatic cells). These cells have a full two sets of chromosomes, so we consider them diploid (2n). One set of chromosomes comes from Mom (maternal) and one set of chromosomes comes from Dad (paternal).

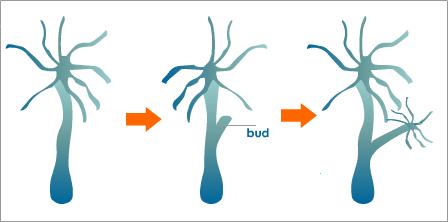
2) Meiosis is the process of creating new sex cells (gametes). These cells have only one set of chromosomes, so we consider them haploid (n).

3) A karyotype is an image that allows us to see all the chromosomes in a particular cell. Human body cells have 46 chromosomes (23 pairs), and human sex cells have 23 chromosomes.

4) Human body cells have two sex chromosomes (X or Y). The female combination of sex chromosomes is XX, and the male combination of sex chromosomes is XY.

5) The remaining 44 chromosomes in a human body cell are called autosomes, which means they are non-sex chromosomes. In a cell, these chromosomes are paired up such that the chromosomes in each pair have the same length, centromere position, and genes controlling the same inherited characteristics. The pairs of chromosomes are called homologous chromosomes.

6) Mitosis can be involved in asexual reproduction, the creation of genetically identical offspring (clones) from a single parent. An example of this process occurs in hydra and is called budding.



7) Meiosis can be involved in sexual reproduction, the creation of genetically different offspring from two parents

8) Meiosis in humans produces sperm and egg cells with 23 chromosomes. During fertilization, one sperm meets up with one egg to create a zygote with 46 chromosomes. This zygote is considered diploid because it has two sets of chromosomes. This diploid zygote can divide by mitosis to create body cells in the new baby with 46 chromosomes each.

9) **Question:** Why must the chromosome number in gametes be half the chromosome number in somatic cells?

**Side-By-Side Comparison of Mitosis and Meiosis**

|  |  |  |
| --- | --- | --- |
| **Characteristic** | **Mitosis** | **Meiosis** |
| Goal | Making new body cells (somatic cells) ; asexual reproduction ; growth and replacement of dead cells | Making sex cells (gametes) ; sexual reproduction |
| Daughter Cells | Two diploid cells (2n) that are genetically identical to the parent cell | Four haploid cells (n) that are genetically different from the parent cell and each other |
| # of Divisions | One | Two (meiosis I and II) |
| Location | In all body cells | In the gonads (ovaries or testes) |
| Picture | mitos diagram | meio diagram |

**Preparing for Meiosis**

10) Before meiosis, the parent cell must go through all the stages of interphase (see mitosis notes) and must duplicate its DNA.

11) This occurs during the S (synthesis) phase of interphase.

12) Once a cell has completed the G2 phase, it can begin meiosis.

**Meiosis I**

|  |  |  |
| --- | --- | --- |
| **Stage Name** | **Description** | **Picture** |
| Starting Materials | * One diploid parent cell |  |
| Prophase I | * Synapsis = pairing of homologous chromosomes * Forms a tetrad (group of four sister chromatids) * Allows for crossing over = exchange of DNA between homologous pairs * Chiasma (pl. chiasmata) = regions where crossing over has occurred * The nuclear envelope and nucleolus break down * The mitotic spindle forms and centrosomes move towards the poles of the cell |  |
| Metaphase I | * Kinetochores connect to mitotic spindle fibers (prometaphase) * Homologous pairs line up at the metaphase plate |  |
| Anaphase I | * Homologous chromosomes separate (chromatids on a single chromosome DO NOT separate yet) * Segregation = separation of homologous partners to different daughter cells * Independent Assortment = mixing of paternal and maternal chromosomes (grandparent chromosomes) in different combinations… each chromosome pair lines up differently / independently along the metaphase plate |  |
| Telophase I | * Some (but not all) organisms’ nuclear envelopes reform and chromosomes unwind into chromatin before the second division |  |
| Cytokinesis I | * The cytoplasm divides | See picture above |
| Product | * Two haploid cells (1n), each with chromosomes that have two chromatids (identical copies of DNA) | See picture above |

*Note: I have left out prometaphase, but you should assume that this occurs as well!*

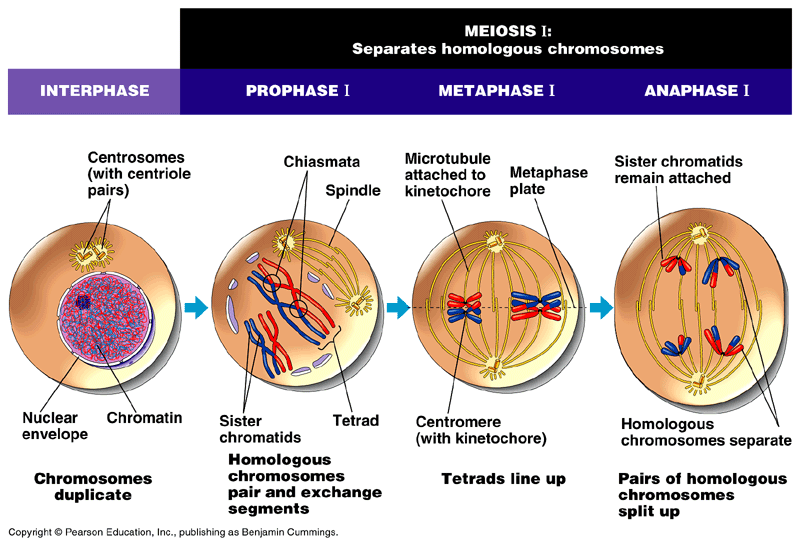
**Meiosis II**

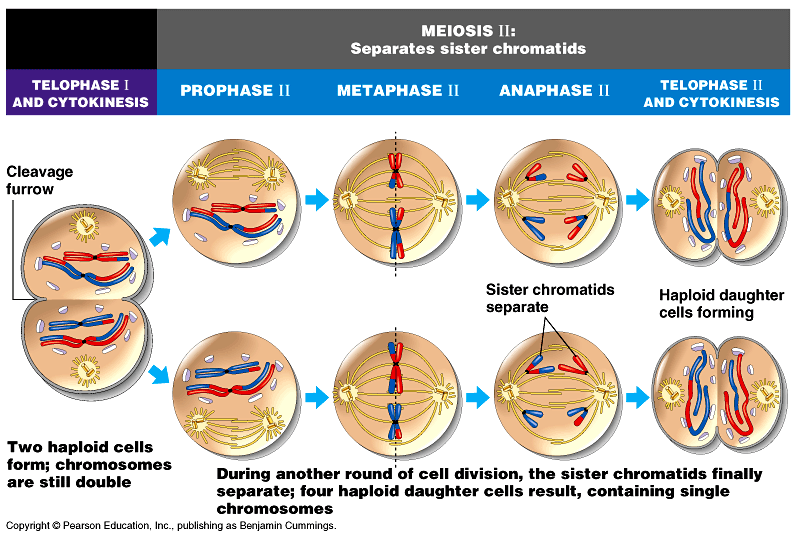
|  |  |  |
| --- | --- | --- |
| **Stage Name** | **Description** | **Picture** |
| Starting Materials | * Two haploid cells, each with chromosomes that have two chromatids (identical copies of DNA)… the products of Meiosis I ☺ | No picture, sorry! |
| Prophase II | * If chromosomes unwound after Meiosis I, they wind back up again * If the nuclear envelope reformed after Meiosis I, it breaks down again * If the mitotic spindle has broken down after Meiosis I, it is reformed * Centrosomes move to opposite poles of the cell | Assume this happens twice (once with each of the starting cells) |
| Metaphase II | * Kinetochores connect to mitotic spindle fibers (prometaphase) * Chromosomes line up SINGLE FILE along the metaphase plate | Assume this happens twice (once with each of the starting cells) |
| Anaphase II | * Chromosomes separate into two sister chromatids that move to opposite ends of the dividing cell | Assume this happens twice (once with each of the starting cells) |
| Telophase II | * The nuclear envelope reforms * Chromosomes unwind into chromatin * The mitotic spindle and centrosomes disappear | Assume this happens twice (once with each of the starting cells) |
| Cytokinesis II | * The cytoplasm divides | See picture above |
| Product | * Four haploid cells (1n), each with chromosomes that have only one chromatid * These cells are considered gametes (ex: sperm and egg) / the final products of meiosis |  |

*Note: I have left out prometaphase, but you should assume that this occurs as well!*

13) Chromosomes are not copied between divisions!

14) **Question:** What are the main differences between Meiosis I and Meiosis II?





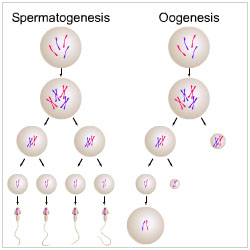
15) **Question:** Which process is most similar to mitosis – Meiosis I or Meiosis II? Why?

**Advantages of Sexual Reproduction**

16) Sexual reproduction produces offspring that are genetically different from the parents ; this creates genetic variation within a population of organisms and makes the population less susceptible to environmental stressors (ex: a disease may only wipe out organisms with a particular gene).

17) Three ways that meiosis produces genetic variation

* Variation from crossing over: mixing of genes between homologous chromosomes… creates an INFINITE variety of possible genetic combinations
* Variation from independent assortment of chromosomes: random alignment of homologous chromosomes along the metaphase plate during Metaphase I… independent assortment in humans produces 223 (8,388,608) different combinations in gametes (see image on page 248 of your textbook)
* Variation from independent assortment: which sperm fertilizes which egg?... any two parents will produce a zygote with over 70 trillion (223 x 223) possible diploid combinations (and this doesn’t even take into account crossing over!)

**Meiosis in Humans**

18) **Spermatogenesis**: the process of creating male gametes (sperm); meiosis produces four haploid cells; maturation adds tails 🡪 four functional sperm; Occurs in the testes (singular: testis)

19) **Oogenesis:** the process of creating female gametes (eggs or ova); the cytoplasm divides unevenly and produces one egg (lots of cytoplasm) and three polar bodies (have DNA but very little cytoplasm) ; the polar bodies later degenerate ; this process gives the egg the best start with all the resources it needs; Occurs in the ovaries